

Class A Release  
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APOLLO MINIMUM WORKMANSHIP, FABRICATION, AND  
INSPECTION REQUIREMENTS FOR WIRING  
AND RESISTANCE - WELDING OF ELECTRONIC  
CIRCUIT MODULE AND ASSEMBLIES

Record of Revisions

Date	Revision Letter	TDRR	Pages Revised	Approvals	
				MIT	NASA

This specification consists of pages 1  
through III and 1 to 14 inclusive.

APOLLO MINIMUM WORKMANSHIP, FABRICATION, AND  
INSPECTION REQUIREMENTS FOR WIRING  
AND RESISTANCE - WELDING OF ELECTRONIC  
CIRCUIT MODULE AND ASSEMBLIES

The purpose of this document is to establish the minimum requirements for  
workmanship of electrical connections by resistance welding to be used in  
the assembly of Apollo Guidance and Navigation Equipment.

WLC/jep/RAug64  
MIT/DATE

Thomson/8/18/64  
NASA/MSD/DATE

APOLLO MINIMUM WORKMANSHIP, FABRICATION, AND  
INSPECTION REQUIREMENTS FOR WIRING  
AND RESISTANCE - WELDING OF ELECTRONIC  
CIRCUIT MODULE AND ASSEMBLIES

1. Scope

1.1 Purpose

This specification establishes the minimum workmanship, fabrication,  
and inspection requirements for wiring and resistance welding of  
airborne electronic circuit modules and assemblies.

2. Reference Documents

2.1 The following documents of the issue in effect on the date of  
application of this document form a part of this document to the  
extent specified herein:

- ND 1002005: Apollo Requirements for Process Control and  
Fabrication of Resistance-Welded Electronic  
Circuit Modules and Assemblies
- ND 1002025: Apollo Requirements for Repair and Rework of  
Resistance-Welded Electronic Circuit Modules  
and Assemblies
- ND 1002004: Process Specification, Epoxy Bonding of Metallic  
and Non-Metallic Materials
- SCD 1006776: Insulation Sleeving, Electrical

3. Requirements

3.1 General

The provisions of this specification shall be applicable to all phases  
of welding of electrical connections to the extent specified herein.  
Specific requirements or provisions not covered by this specification  
shall be specified on the applicable drawing. In the event of conflict  
between the requirements of the applicable drawing, this specification  
and other documents cited herein, the requirements of the applicable  
drawing, this specification and the other documents specified herein  
shall govern in that order.

3.2 General Requirements

3.2.1 Fabrication Requirements

All machines, tools, material, and personnel utilized in the  
fabrication of articles presented for acceptance under the  
provisions of this document shall, at the time of fabri-  
cation, have been qualified in accordance with the provisions  
of Reference Document, ND 1002005. Similarly, all oper-  
ating documents employed in this fabrication will have been  
those currently approved for such application.



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1. Scope

1.1 Purpose

This specification establishes the minimum workmanship, fabrication, and inspection requirements for wiring and resistance welding of airborne electronic circuit modules and assemblies.

2. Reference Documents

2.1 The following documents of the issue in effect on the date of application of this document form a part of this document to the extent specified herein:

ND 1002005:	Apollo Requirements for Process Control and Fabrication of Resistance-Welded Electronic Circuit Modules and Assemblies
ND 1002025:	Apollo Requirements for Repair and Rework of Resistance-Welded Electronic Circuit Modules and Assemblies
ND 1002004:	Process Specification, Epoxy Bonding of Metallic and Non-Metallic Materials
SCD 1006776:	Insulation Sleeving, Electrical

3. Requirements

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The provisions of this specification shall be applicable to all phases of welding of electrical connections to the extent specified herein. Specific requirements or provisions not covered by this specification shall be specified on the applicable drawing. In the event of conflict between the requirements of the applicable drawing, this specification and other documents cited herein, the requirements of the applicable drawing, this specification and the other documents specified herein shall govern in that order.

3.2 General Requirements

3.2.1 Fabrication Requirements

All machines, tools, material, and personnel utilized in the fabrication of articles presented for acceptance under the provisions of this document shall, at the time of fabrication, have been qualified in accordance with the provisions of Reference Document, ND 1002005. Similarly, all operating documents employed in this fabrication will have been those currently approved for such application.



3.2.4. Module Bus Wiring routing as shown on mylar film is intended as a general guide and should be followed as closely as possible. However, it need not be adhered to exactly provided the standards of this specification are maintained.

3.2.5. Module Bus Wire Ribbon shall be routed point to point in a straight line or a smooth curve and shall be free of kinks or twists in accordance with the standards of this specification unless otherwise specified by design.

### 3.3 Insulation

#### 3.3.1 Use

Insulation shall be used when uninsulated conducting materials are closer than .020" to other uninsulated conductive materials (see fig. 1) Clearance of less than .010" shall be cause for rejection.

#### 3.3.2 Insulating Covers

When the .020" clearance of item 3.3.1 has not been maintained, at least .010 insulation shall be applied to one of the items. Whenever possible, this insulation shall be a sleeve type insulation per SCD 1006776. If the sleeve type insulation cannot be used, an insulating cement per ND-1002004 Type II shall be used and shall not obstruct the quality characteristics of the part or assembly. (see fig. 1)



Figure 1

### 3.3.3 Clearance between Insulated Wire and Bus Wire.

- 3.3.3.1 Insulated wire in a horizontal plane. Ends of bus wire shall have a minimum clearance of .010" when adjacent to insulated wire. This is established to prevent insulation damage. (See Fig. 2) If less than .010" clearance exists, insulating cement per ND-1002003, Type II or type V shall be applied to the end of the ribbon completely filling the gap between the ribbon and the sleeve.

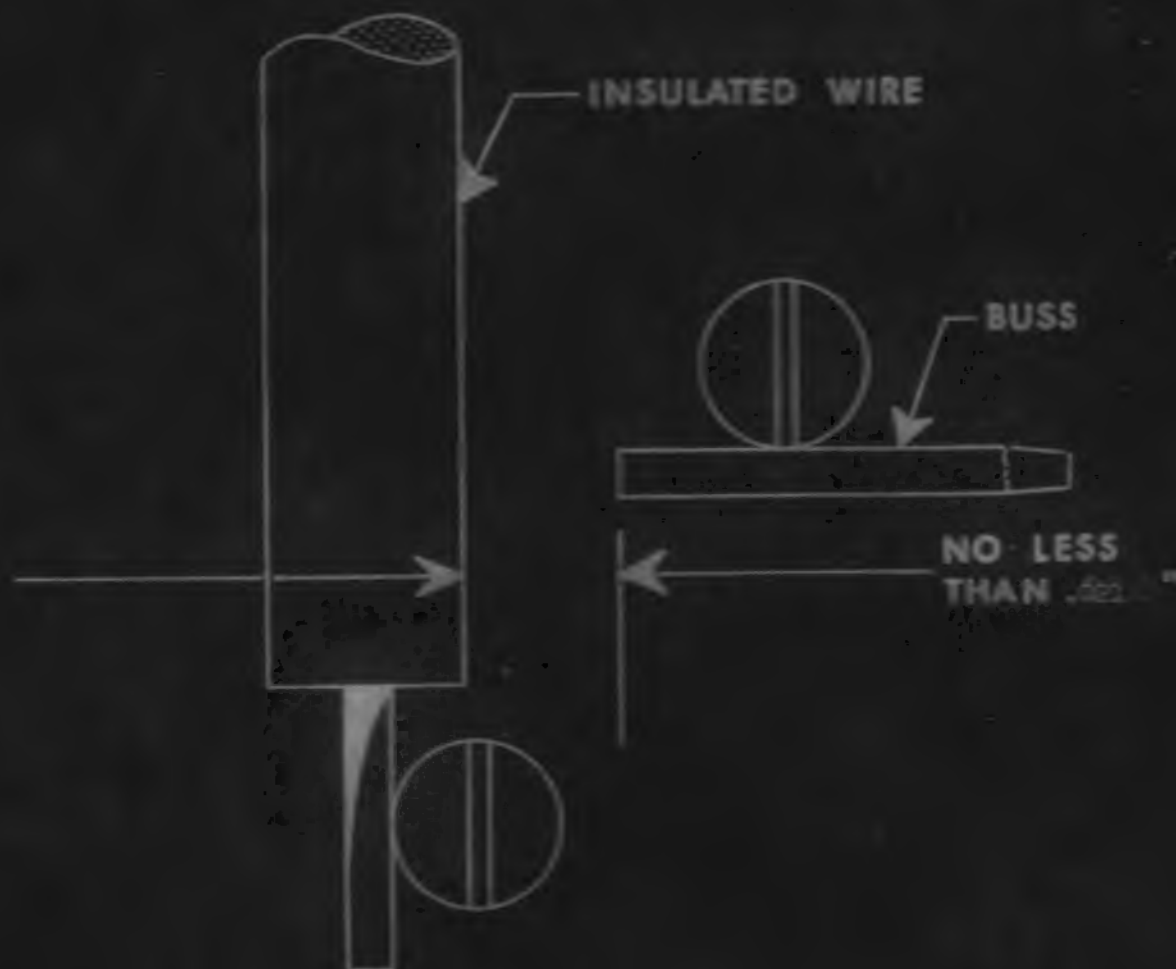


Figure 2





- 3.3.4 Unless otherwise specified by the applicable drawing, runs between welds shall not exceed  $\frac{3}{4}$  inch without sleeving, mylar, or other approved insulation. Runs less than  $\frac{3}{4}$  inch must be sleeved if it is believed that danger of shorting exists. (See Figure 3)

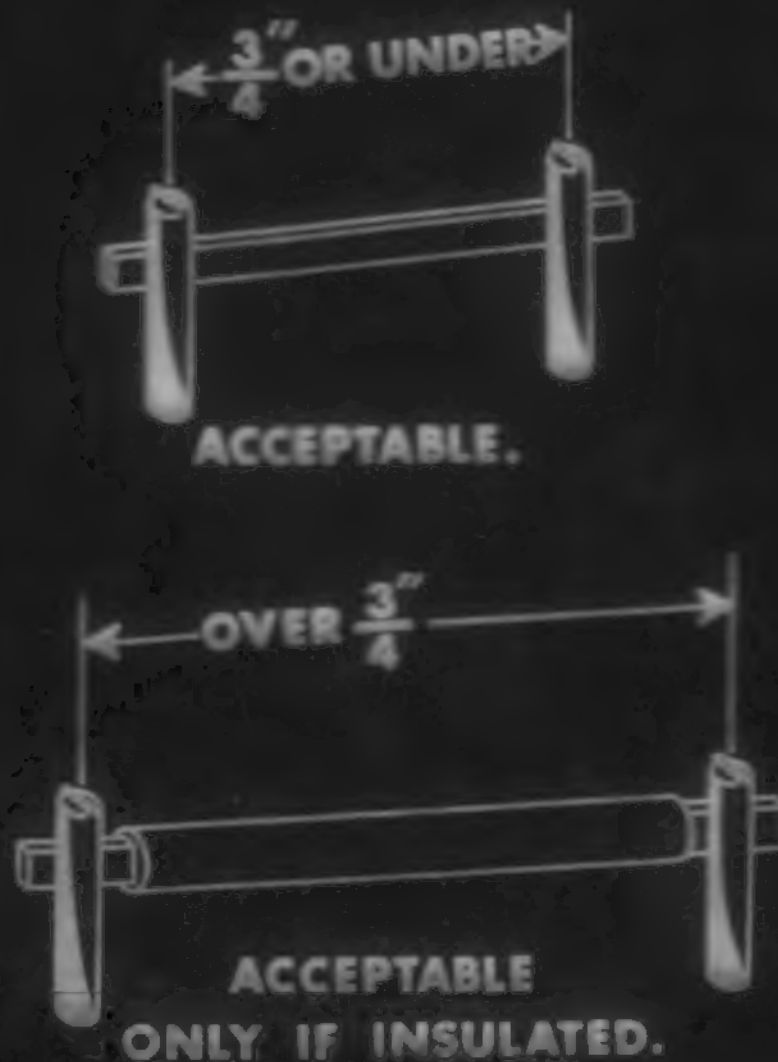


Figure 3



- 3.3.5 Unless otherwise specified by the applicable drawing, when 2 buses on 2 levels cross, the longer bus of the 2 shall be suitably insulated with sleeving, mylar film, or other approved insulation so that a shorting situation will not exist. (See Fig. 4)

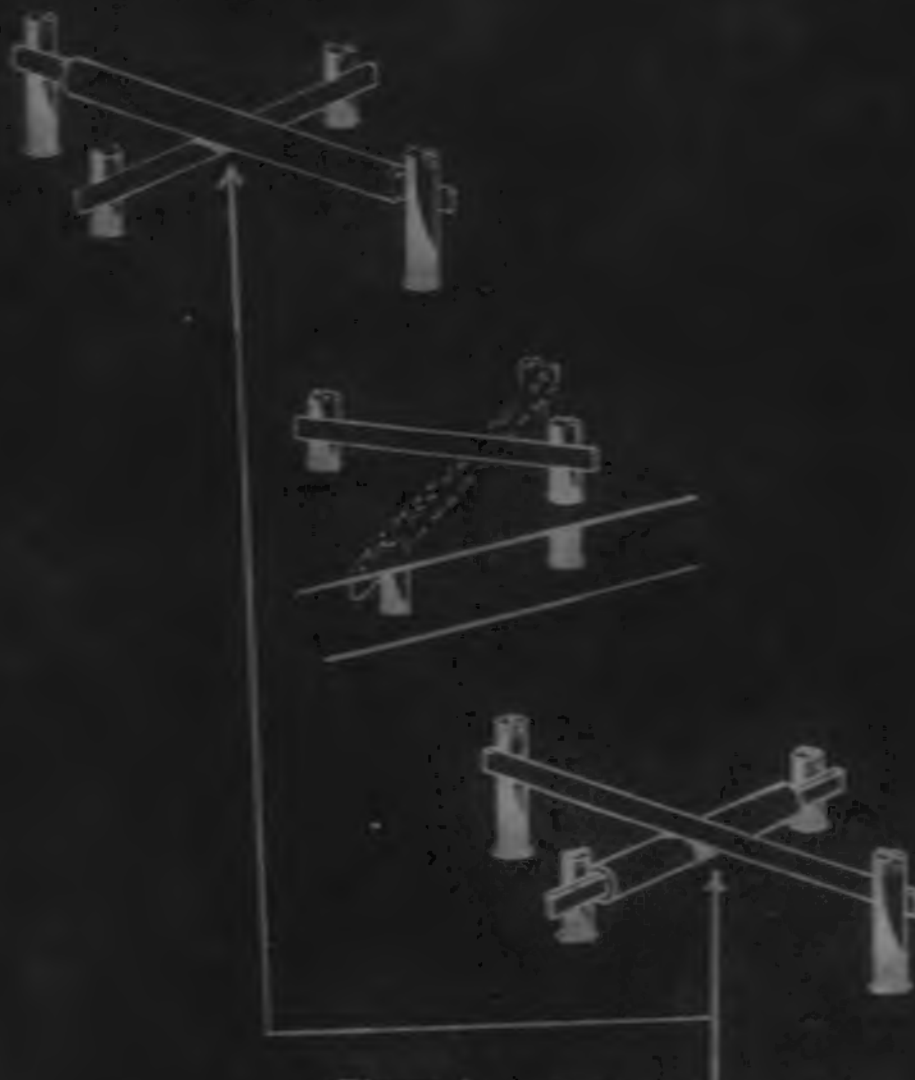


Figure 4 .010" minimum clearance between Bus and insulation must exist, or else gap must be filled using insulating cement per ND 1002004, Type II

### 3.3.6 Insulation of welded matrices

Sheet used to insulate a welded matrix will be free of pin holes, cracks, or tears throughout the fabrication and installation cycle.

## 3.4 Welding Requirements

### 3.4.1 Operating Documents

The welding operations of each welded assembly will be governed by written direction that includes the following as a minimum.

- a. The machine settings required to make each specific joint.
- b. Application instructions for all tooling unique to the specific assembly at the welding operation.

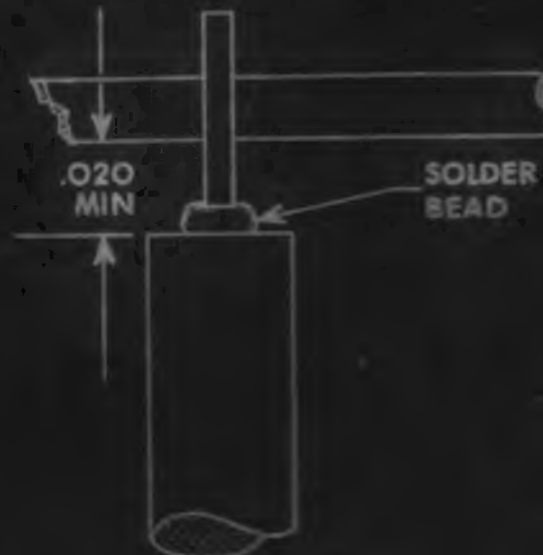
### 3.4.2 Positioning of Material Intersection

The material to be joined will be positioned such that the intersection of the interconnecting material with the component lead shall, after welding, form an angle of  $90^\circ$  plus or minus 10 degrees.

### 3.4.3 Positioning Interconnecting Ribbon

#### 3.4.3.1 Ribbon to Component

The interconnecting material (ribbon) shall, prior to welding, be positioned such that a .020" clearance minimum exists between the ribbon and any component body. It is imperative that the ribbon shall be welded to the weldable portion of the component lead.



11

10



PLATE 11  
LUNAR MODULE

Apollo G  
ND 10720



PSA and GME Modules







050" Min. Straight



NOT ACCEPTABLE

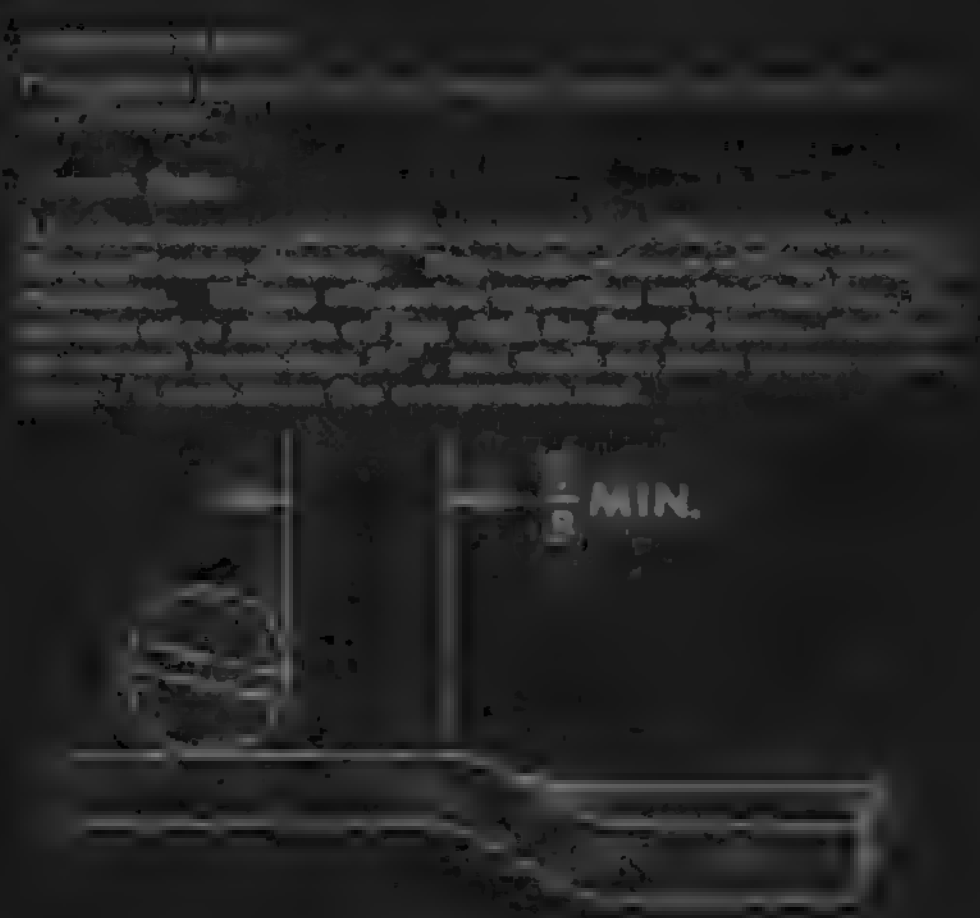
ACCEPTABLE

ACCEPTABLE









- 3.5.3 There shall be no sandwich welds. A sandwich weld is defined as a joint having more than two (2) weldments. If two or more buses are to be welded to the same lead, the weld areas shall be staggered with no overlap. (See Figure 12).

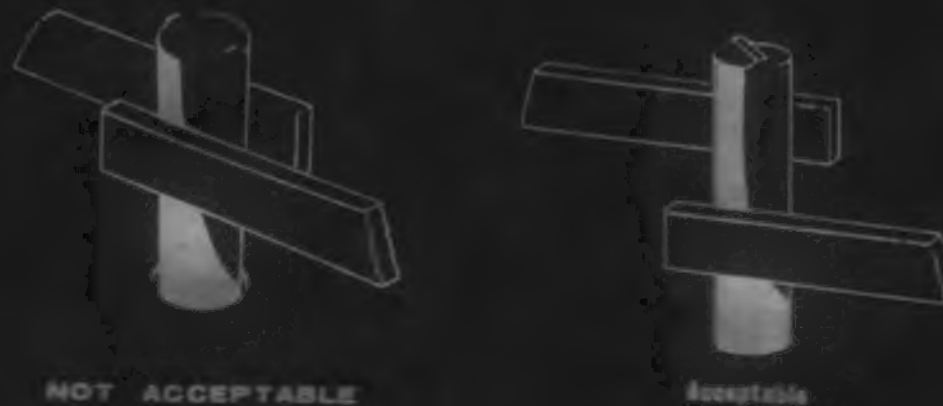


Figure 12

In addition there shall be no butt or lap welding.

3.6 Repair and Rework

All repair and rework of items rejected under the provisions of this document shall be performed in accordance with the provisions of specification ND 1002025.

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Date	Revision Letter	TDRR No.	Page Revised	Approvals	
				AC	NASA
8/18/64	A	17903	11 through 15 page 11A added	WJC	WJB
8/18/64	B	27181	11-15 was 15 pages now 16 pages	WJC	---
8/26/64	C	28077	4, 5	WGM EA	---

This specification consists of page 1 to 16 inclusive.

APPROVALS	J. Bernard	W. Kupler	G. Mayo	D. B. Test	AC
	8/18/64 NASA/MSC		8/18/64 MIT/IL	8/18/64 A. M. Levenson	



3.3.3.2 Insulated Wire in the Vertical Plane. Ends of bus- or component wire shall have a minimum clearance of .020" when adjacent to insulated wire. This is established to prevent insulation damage. (See Fig. 1A) If less than .020" and at least .010" clearance exists, insulating cement per ND1002004 Type I, Type II or Type V shall be applied to the ribbon or component lead completely filling the gap between.



FIGURE 1